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(54) MESSAGE RETRIEVING ORGANIZATION

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This invention relates to information translating arrangements, and more specifically, to an organization for retrieving messages processed by store and forward communications systems.

Electronic store and forward switching systems include data message centers which accept transmissions from various remote subscriber stations, temporarily store the messages or blocks thereof in a memory circuit, and deliver the messages to appropriate receiving station(s) in accordance with routing codes contained in the message headings. It has been found desirable in such organizations to allow subscribers to retrieve messages previously originated by and/or previously forwarded to them.

One method of embodying this function is to maintain a continuous record of the successive messages processed by the composite store and forward system on a plurality of sequentially employed journal magnetic tape reels. Then, when a retrieval is desired, a point by point search of the journal tapes is made until a reference to the desired message is encountered. However, this marching procedure is cumbersome, inefficient, and time consuming as several journal tapes may have to be scanned for each retrieval request.

It is therefore an object of the present invention to provide an improved message retrieval organization for store and forward message communications systems.

More specifically, an object of the present invention is the provision of a message retrieval arrangement which processes plural retrieval requests in a fast and efficient manner.

These and other objects of the present invention are realized in a specific illustrative organization for permitting a subscriber to a store and forward communications system to

retrieve messages associated with his station. The arrangement comprises a plurality of permanent file magnetic tape embodiments upon which are sequentially written the subscriber messages, independent of their source or destination. Coincidentally therewith, a cross reference storage file is generated and organized by subscriber message number by an indirect addressing and storage shifting pointer process.

As message retrievals are requested by various service subscribers, the requests are queued into linked lists arranged by permanent file tape reel and record number. A memory interrogating circuit then operates on the queued requests in accordance with a search strategy to communicate the desired messages to the subscribers requesting the retrievals.

It is thus a feature of the present invention that a message retrieval organization include a plurality of subscriber stations having messages associated therewith, a plurality of sequentially employed message permanent storing units for storing the subscriber messages associated with said stations, a cross reference storage element, circuitry responsive to the origination of a message from any one of the stations for entering the permanent storage location which will contain this message in a portion of the cross reference storage element associated with the particular station originating the message, circuitry responsive to each retrieval request generated by the stations for extracting a list of permanent storage locations associated with the requesting station from the cross reference storage element, and circuitry for ordering the extracted locations by permanent storage unit.

A complete understanding of the present invention and of the above and other features, advantages and variations thereof may be gained from a consideration of the following detailed description of an illustrative embodiment thereof presented hereinbelow in conjunction with the accompanying

drawing, in which:

FIGS. 1A through 1C comprise a block diagram of an illustrative message retrieval organization which embodies the principles of the present invention;

FIG. 2 illustrates the message storage pattern characterizing a plurality of tape reels M through Z included in the arrangement illustrated in FIGS. 1A through 1C;

FIGS. 3A through 3I depict the storage pattern exhibited by a cross reference memory 50 included in the arrangement of FIGS. 1A through 1C at various points in system functioning;

FIGS. 4A through 4D depict the storage pattern characterizing a queuing memory 100 included in the arrangement of FIGS. 1A through 1C at various points in system functioning; and

FIG. 5 illustrates the spatial organization of FIGS. 1A through 1C.

Referring now to FIGS. 1A through 1C, hereinafter referred to as composite FIG. 1, there is shown a specific illustrative message retrieval organization operative in conjunction with a store and forward communication system. The store and forward information translating arrangement includes a plurality of station sets 10 which are operable to register messages in a message memory 25 by way of a translation network 20 and a common control unit 30. The common control unit 30 may advantageously comprise a stored program controlled structure as disclosed, for example, in a pending Canadian application by A.H. Doblmaier-R.W. Downing-M.P. Fabisch-J.A. Harr-H.F. May-J.S. Novak-F.F. Taylor, Serial No. 914,180, filed October 16, 1964 (also described in the Bell System Technical Journal, September 1964). Specifically, the central processor of the system (described in Bell System Technical Journal id, pages 1855-1933) could be

programmed to perform the function of the common control unit 30 as hereinafter described. The translation network 20 may advantageously comprise the assembler disclosed in R.E. Swift U.S. Patent 3,340,513, issued September 5, 1967. The Swift assembler scans a plurality of incoming data lines, receives data transmitted thereover, and applies the data to an output circuit of some type which in our application would be the common control unit 30.

At some time following the storage of messages in the memory 25, the information is forwarded by the common control unit 30 and the network 20 to selected ones of the station sets 10 which are identified in the message heading.

It has been found desirable in such store and forward communications systems to allow subscribers at message originating and/or receiving stations 10 to retrieve messages previously sent or received by them. Also, such a system capability is desired for administration and message tracing purposes.

To this end, a plurality of tape units 40 are employed to store on a plurality of tape reels each message processed by the store and forward system and registered in the message memory 25. More particularly, the units 40_1, 40_2, and 40_3 are each on line, and provide an interface for a bidirectional information flow between the common control unit 30 and a plurality of tape reels M, N and O respectively mounted thereon. Correspondingly, the tape unit 40_4 is employed to selectively accept one of a plurality of off line tape reels P through Z, and to send the information thereon to the control unit 30. The tape units 40 and the tape reels M through Z associated therewith comprise a permanent file storage of all messages processed by the composite FIG. 1 arrangement within a time period of interest, e.g., one week.

The common control unit 30 is adapted or programmed to select one of the tape units 40_1 through 40_3 by energizing a

corresponding one of a plurality of control leads 38. The selected unit 40 stores on consecutive records of the tape reel mounted thereon the messages which are sequentially processed by the unit 30 and registered in the message memory 75, independent of the source or destination of the messages. When one tape reel becomes full, another reel is selected by the common control unit 30 which energizes a different one of the control leads 38. After each of the reels on the units 40_1 through 40_3 is completed, the oldest one in point of time is taken off line, and replaced by a clear reel which accepts succeeding system messages. In the drawing, the tape reels P through Z comprise the oldest, off line tapes, while the reels M, N, and O comprise the most recent, on line tape embodiments.

A cross reference file memory 50 is included in the FIG. 1 arrangement, and functionally divided into a plurality of like size storage blocks of, for example, thirty-two words each. The storage blocks included in the cross reference memory 50 comprise a pool of common file blocks (FB), a plurality of accumulating blocks (AB), and a plurality of summary blocks (SB, with one pair of the latter two type storage areas being permanently dedicated to each station 10 desiring message retrieval service.

The cross reference memory 50 is organized in accordance with the identity of the several station sets 10, and is functionally employed to list the tape reel and record information identifying the permanent file storage locations containing the beginnings of the messages associated with the subscribing stations 10.

To effect this cross reference storage, a station message counter 58 employs a binary counter for each station 10, with each counter being initially set to 00000, indicating a message count of one. Each time a message associated with a

station 10_i is registered in the message memory 25, and thereby also in permanent file storage, the identity of the station is sent to a translator 55 by way of the common control unit 30 and a control bus 33. The station designation is also communicated to the message counter 58, with the counter associated with the particular station 10_i being advanced by one after process of each message is complete.

The status of the relevant message counter comprises a message number which identifies the particular message associated with the station set 10_i that is presently being processed by the FIG. 1 system. Accordingly, the message number is communicated to the subscriber at the station set 10_i for his records via a bus 34, the common control unit 30 and the translation network 20.

The translator 55 converts the station 10_i designation supplied thereto by the bus 33 into a cross reference file memory 50 address corresponding to the beginning of the accumulating storage block associated with the station 10_i. This address is supplied as a first input to a digital adder 62.

The message counter associated with the station 10_i supplies its output to a modulo 32 converter 60, with the output of the converter 60 comprising a representation of the subject message number quantized to the range 1 through 32, i.e., to the binary words 00000 to 11111. Where a conventional binary code is employed, the converter 60 simply comprises a deletion of all but the five least significant digits of the counter output message number representation. The modulo 32 modification of the station counter output message number comprises a second input to the adder 62.

A memory 50 accessing structure 64 is responsive to the output of the adder 62 for enabling a memory 50 address given by the sum of the beginning accumulating block address associated with the station 10_i and the modulo 32 replica of the station

message count. The permanent file storage location of the beginning of the subject message associated with station 10_i, i.e., a tape reel designation and particular record thereof, is then stored in this enabled memory 50 location. The reel and record quantities are respectively stored in the left and right bytes, or portions of the memory 50 storage location enabled by the accessor 64. This information is supplied to the memory 50 by the common control unit 30 by way of a bus 31.

As messages associated with other station sets 10 are processed by the store and forward system of FIG. 1, they are placed in permanent file storage on the tape reel then employed by the common control unit 30. Moreover, the permanent storage locations of such messages are written into the cross reference memory 50 accumulating blocks dedicated to the corresponding stations 10. As additional messages associated with any station 10, for example the above-considered general station 10_i, are encountered, the corresponding permanent file storage locations are written into contiguous storage cells in the associated accumulating block through the action of the buses 31 and 33, the translator 55, the sequentially advanced message counter in the embodiment 58, the module 32 converter 60, the adder 62, and the memory 50 accessor 64.

When the system has processed thirty-two messages associated with the station 10_i, the accumulating storage block dedicated thereto is filled, i.e., there are 32 permanent file storage locations registered therein to identify the tape reel and record numbers containing the beginning locations of the 32 messages associated with the station 10_i and processed by the store and forward structure. Also, when the above conditions prevail, the message counter in the embodiment 58 and the module 32 converter 60 are each characterized by the binary word 11111 indicating a message count of 32.

A detector 68 is responsive to the 11111 converter 60 output signal for enabling a summary block updating circuit 66 and a storage shifting circuit 72. The storage shifting embodiment 72 is operative when energized by the detector 68 for seizing a common file block specified by a storage allocating circuit 74, and for placing therein the contents of the now full accumulating storage block associated with the station set 10_i. After this signal translation is completed, thirty-two additional messages associated with the station 10_i, i.e., its message numbers 33 through 64 may be processed by the FIG. 1 organization.

Coincidentally therewith, the enabled summary block updating circuit 66 is adapted to place the address of the leading storage cell of the seized file block in the summary block of the cross reference file memory 50 dedicated to the station 10_i. In addition, the circuit 66 places in the above noted summary block storage cell the current date and time which is supplied thereto by a system clock 70.

The above-described system functioning reoccurs each time the module 32 converter 60 supplies the signal 11111 to the detector 68, i.e., when the message counter associated with the station 10_i indicates that the messages 64, 96, 128, et cetera for the station 10_i has been encountered. For each of these messages identified by a message number comprising an integer multiple of thirty-two, a new common file block is seized, the then full associated accumulating block is emptied therein, and the location of the leading cell of the file block, along with the current date and time, is registered in the associated summary block.

To effect a message retrieval operation, a station set 10 transmits the message number and the approximate date and time of the desired message to the common control unit 30. The unit 30 then impresses the identity of the set 10 originating the retrieval, the message number, and the date and time

information in a retrieval request register 78.

A translator 76 is employed to convert the station act designation into the beginning address of the corresponding summary block. A memory 50 accessor 77 is next enabled by the translator 76 for reading out from the designated summary block of the cross reference file memory 50 the contents of two contiguous storage cells, i.e., a storage couplet comprising the first, or oldest, date and time entry and also the associated storage location of the beginning address of the first seized file block.

The date and time information derived from the summary block of the cross reference memory 50 is compared by a comparator 80 with the corresponding data stored in the register 78. If the request-associated date and time is later than the quantity readout from the memory 50, the comparator 80 causes the memory accessor 77 to interrogate the next storage couplet included in the summary block. The process continues until the entry in the register 78 is found to post-date the date and time contained in the memory, which indicates that the file block identified by the last previous storage couplet contains the permanent file storage location at which the desired message may be found.

When the proper cross reference file memory 50 summary block couplet has thus been located, the date and time comparator 80 enables an adder 82 for generating a memory 50 address comprising the sum of the beginning address of the desired file block as read out from the memory 50, and a modulo 32 representation of the desired message number, with this latter quantity being supplied to the adder 82 by the register 78 via a modulo 32 converter 81. A memory 50 accessor 85 then interrogates the cross reference memory 50 address specified by the adder 82, with the contents of this memory location comprising the desired permanent file storage location at which the subject

message to be retrieved begins. This output from the cross reference memory 50 appears on a plural conductor bus 89.

Since the permanent file address on the bus 89 contains the desired permanent file location, this information might be directly employed by the control unit 30 to interrogate the corresponding permanent file tape reel and record. However, when many retrieval requests are anticipated, such a mode of operation is inefficient and time consuming, since consecutively encountered requested messages would, in general, be found on different tape reels, or on widely separated records of a single reel.

To ameliorate these difficulties, the retrieved permanent file storage addresses appearing on the bus 89 are arranged in a queuing memory 100 by tape reel and, within any single tape reel grouping, by record number. A queuing memory 100 accessor 105 is adapted to extract the permanent file location stored in the queuing memory 100 in accordance with some search strategy, for example in the simplest case by sequentially reading out all of the entries for all of the tape reels in the alphabetical order of their designating letters.

The permanent file storage locations derived from the queuing memory 100 are sequentially supplied to the common control unit 30 via a bus 36, with the messages associated with these locations being sequentially read out from permanent file storage by the common control unit and transmitted therefrom to the data sets 10 originating the several requests. Since the tape reels M through Z are examined for retrieval purposes in alphabetical order, with multiple requests for any single tape reel being organized by record number, the message extracting operation proceeds in a rapid, organized and efficient manner.

To order the permanent file storage locations which appear on the bus 89 responsive to plural message retrieval

requests, the queuing memory 100 is organized by related sets of two contiguous storage locations, or couplets. In particular, associated QUEUE START and QUEUE END fixed storage cells are dedicated to each tape reel, with the remainder of the memory 100 comprising a pool of common linking couplets.

When a permanent file storage location is impressed on the bus 89, the tape reel identification or left byte is directed to a translator 90 which converts the tape reel identity into a QUEUE START address in the queuing memory 100 associated with that particular reel. The memory 100 address is supplied to a retrieval request queuing circuit 93. In addition, the record number or right byte of the permanent file location impressed on the bus 89 is directly propagated to the circuit 93.

For the first retrieval request for a particular tape reel, e.g., the tape reel M, the circuit 93 seizes a linking couplet from the common pool under control of the storage allocating circuit 74. The queuing circuit 93 then inserts the memory 100 address of the first seized couplet cell in the M QUEUE START storage location, and further functions to insert the address of the storage cell M QUEUE END in the second seized couplet cell. Moreover, the queuing circuit 93 writes the tape reel M designation, the particular reel record number and the identity of the station set 10 requesting the retrieval in the first couplet storage cell.

As additional requests for message retrievals from the tape reel M are received by the queuing circuit 93, additional linking couplets are seized, and the first storage cells of the previously employed tape reel M linking couplets are sequentially examined. When a record number stored therein is uncovered which is greater than the record number of the subject retrieval location, the address of this cell is inserted in the second storage cell of the new couplet, with the particular record number satisfying the la[illegible] request being placed in the first couplet

cell. Then also, the address of the first cell of the new couplet is inserted in the second cell of the couplet containing the previous record number examined, i.e., the next smallest tape reel M record number. This process continues in a recursive manner, such that all requests for retrievals of messages stored on the tape reel M are ordered in a linked list, independent of the particular station sets .0 requesting the retrievals. The function carried out by the queuing circuit 93 is a straightforward method of ordering retrieval requests. Other arrangements could be employed such as that disclosed in copending Canadian patent application of L.E. Gallaher, Serial No. 956,140 filed March 26, 1966.

When the memory 100 accessor 105 interrogates the stored tape reel M retrieval requests, it first goes to the location M QUEUE START and reads out the address of the lowest record number on tape reel M for which a retrieval is requested. This location is then interrogated, with the reel M, record number, and station identifying data being translated by way of the bus 36 to the common control unit 30 for processing.

The memory accessor 105 next looks at the second cell of the first linking couplet, and is supplied with the address of the memory cell containing the second smallest tape reel M record number. This address is examined, and the resulting product supplied to the common control unit 30. This mode of data processing continues until the last and largest stored tape reel M record number is supplied to the unit 30 for processing, at which time the accessor 105 is referred to the queuing memory 100 cell M QUEUE END, from which it is transferred to the location M QUEUE START to extract the retrieval requests for the tape reel M. Each cell i QUEUE START is initially adapted to contain the address of the next following cell, viz., i QUEUE END, such that if a null list is encountered, i.e., there are no retrieval requests for the reel i, the queuing memory 100

accessor 105 will next be operative in accordance with the contents of the location 1 QUEUE END to examine the retrieval requests for the succeeding tape reel 1.

The above-described system functioning continues until the ordered tape reel 2 list is exhausted, at which time the memory accessor 105 initiates the above processing anew by again examining the retrieval requests for messages stored on the tape reel M which may have been received since the reel M list was last interrogated.

If retrieval requests for off-line tape reels are received by the common control unit 30 from the queuing memory 100, the unit 30 signals a visual operator display circuit 95 to indicate which off-line tape reel is desired. A visual display is then generated by the circuit 95 to apprise an operator of the requirement for mounting the desired off-line tape reel on the tape unit 40_4 so that the desired message may be extracted therefrom. The operator display circuit 95 could advantageously comprise teletypewriter apparatus such as that discussed in Bell System Technical Journal, September, 1964, No. 5., Part 2, pp. 2283-2295.

Thus, the composite FIG. 1 arrangement has been shown by the above to rapidly and efficiently process message retrieval requests by generating a cross reference storage file organized by the several subscriber stations independent of the permanent file location of the corresponding messages, and by ordering by tape reel and record number all permanent file locations retrieved from the cross reference file.

It is noted at this point, that specific embodiments for the operational units shown in block diagram form in FIG. 1 and considered hereinabove are apparent to those skilled in the art in view of the corresponding functional sequencing thereof.

To further illustrate the system functioning of the FIG. 1 message retrieval organization, assume that the data station sets 10_2 and 10_6 have originated the messages identified in Table I, infra. Table I discloses only selected ones of the messages transmitted by the station sets 10_2 and 10_6, and does not relate system messages associated with any of the other station sets 10.

TABLE I

Selected System Messages

Station Set	Station Message No.	Tape Reel	Record No.	Day	Time
10_6	5	Z	34	Mon.	9:30 a.m.
10_2	3	Z	850	Mon.	3:00 p.m.
10_6	32	P	1500	Wed.	10:00 a.m.
10_6	42	P	1900	Thur.	11:30 a.m.
10_2	32	P	2810	Thur.	3:30 p.m.
10_2	40	M	50	Fri.	7:30 a.m.
10_6	68	M	964	Fri.	2:00 p.m.

Interpreting the first row in Table I, which is illustrative of the remaining entries therein, there is indicated the fact that the station set 10_6 sent message No. 5 associated with that station at 9:30 a.m. on Monday of a week being monitored, and that this message is stored in a permanent file storage area which begins with record No. 34 on the tape reel Z.

When a subscriber at the station set 10_6 supplies the message corresponding to the first entry of Table I on Monday morning to the store and forward communications system message memory 25, this message is also written on the tape reel then being employed by the common control unit 30, i.e., the reel Z and in particular record No. 34 thereof, as shown for the tape reel Z in FIG.2. The common control unit 30 communicates the identity of the station set 10_6 to the translator 55 and the

station message counter 58 via the bus 33. The translator 55 responds to the set 10_6 identifying signals by supplying a cross reference memory 50 address 20 to the adder 62, with the address 201 comprising the first storage cell in the accumulating storage block dedicated to the set 10_6, as shown in FIG. 3A.

The message counter associated with the set 10_6 resides in a binary state which indicates that the present message is the fifth one processed by the composite store and forward arrangement for the set 10_6. Accordingly, a message number of five (i.e., 00100 or binary 4) is assigned to the communication and translated to the station set 10_6 via the lead 34, the common control unit 30, and the translating network 20.

The adder 62 generates the cross reference memory 50 address 205 responsive to the received addend 201 and augend comprising message No. 5 (a binary 4) respectively supplied thereto by the translator 55 and the message counter 58. Correspondingly, the cross reference memory 50 accessor 64 is caused by the adder 62 to enable the memory 50 address 205, with the common control unit 30 being operative at this time to supply by way of the bus 31 the relevant permanent file storage location comprising the tape reel identity 2 and the Record No. 34 to the left and right bytes of this enabled memory location. This storage state for the memory 50 following the above-identified message processing is shown in FIG. 3A. It is observed that the memory 50 locations 201 through 204 also contain permanent file location information for the first four messages associated with the station set 10_6 which preceded the above-considered message No. 5 for this station.

In a similar manner, the FIG. 1 arrangement responds to the message transaction identified by the second row of Table I by storing the tape reel 2 and record No. 850 data, corresponding to the permanent file storage location of the third message

associated with the station set 10_2, as shown in FIG. 2, at a cross reference memory address 103 (101 + 2) in the accumulating block associated with the station set 10_2, as illustrated in FIG. 3B.

At some later time when the station set 10_6 originates its thirty-second message, viz., on Wednesday at 10:00 a.m., as indicated in the third row of Table I, the FIG. 1 arrangement again functions in the aforementioned mode, and inserts the corresponding permanent file storage location consisting of the current tape reel identity P and record No. 1500 (FIG. 2) in the thirty-second and last station set 10_6 accumulating block storage location 232, as depicted in FIG. 3C.

However, with the above conditions prevailing, the module 32 converter 60 generates the output binary signal 11111 which activates the detector 68. The storage shifting circuit 72 responds to the activated detector 68 by shifting the contents of the now full station set 10_6 accumulating block into a common file block assigned thereto by the storage allocating circuit 74, e.g., the file block No. 7 which is characterized by a beginning cross reference file memory 50 address 301. Further, the energized detector 68 causes the summary block updating circuit 66 to enter the current date and time in a first storage location in the summary block associated with the set 10_6, i.e., the memory cell 233, and to enter in the next following address 234 the address of the first memory cell in the seized file block, viz., 301. The storage pattern exhibited by the cross reference memory 50 following all processing of the message No. 32 associated with the station set 10_6 is shown in FIG. 3D.

The FIG. 1 message retrieval organization operates on the remaining four messages transmitted by the station sets 10_2 and 10_6 in the general manner indicated above, with the status of the memory 50 following processing of each of these

messages being respecti ely shown in FIGS. 3E, 3G, 3H, and 3I. It is observed that message No. 32 for the station set 10_2 is first registered in the associated accumulating block (FIG. 3F); a file block No. 28 is seized for the set 10_2; and the contents of the accumulating block registered therein. Further, in this regard, the beginning address of the block No. 28, viz. 401, is placed in the summary block associated with the set 10_2 along with the associated date and time information. The final status of the memory 50 following processing of message No. 32 for the set 10_2 is shown in FIG. 3G.

In addition, it is observed that when the 64th (32 x 2) message for the station set 10_6 (not included in Table I) is received on Friday at 12:03 a.m., a second file block, e.g., block No. 50 is seized for the set 10_6, with the beginning address 501 thereof being written into the summary block address 236 which follows the date and time entry at memory address 235.

Assume now that a subscriber at the station set 10_2 communicates to the common control unit 30 that he wishes to retrieve his message No. 3 sent on Monday at 3:00 p.m. and also his message No. 32 sent on Thursday at 3:30 p.m. Further, the station set 10_6 will subsequently be assumed to request a retrieval of his message No. 42 originated on Thursday at 11:30 a.m.

The common control unit 30 responds to the first received request from the station at 10_2 by first transmitting the identity of the source 10_2, the number three characterizing the requested message, and the date and time of Monday, 3:00 p.m., to the request register 78 via the bus 35. The translator 76 converts the identity of the station set 10_2 into the cross reference memory 50 address 133 corresponding to the beginning of the associated summary block. The date and time stored thereat, viz., Thursday at 3:30 p.m., is found by the date and time comparator

80 to be later than the message date stored in the register 78 which characterizes the requested message. Accordingly, the date and time comparator 80 is apprised that the summary block couplet presently being interrogated is the desired one, and renders the adder 82 responsive to the associated file block address 401 stored in the next following memory cell 134. Further, a binary three, indicative of the message number for which a retrieval is being requested, is supplied from the register 78 to the adder 82 by way of the modulo 32 converter 81.

The memory 50 accessor 85 is responsive to the address 403 (401 + 2) generated by the adder 82 for reading out onto the bus 89 the information stored thereat, viz., Z and 850 identifying tape reel Z and record number 850 thereof. This output information is propagated by the bus 89 to the queuing memory 100 for insertion therein.

The initial storage pattern for the queuing memory 100 is shown in FIG. 4A, and comprises QUEUE START and QUEUE END locations for each of the system tape reels, and also a block of common linking cells beginning with a memory 100 address 1000. Since there are initially no retrieval requests, each QUEUE START cell contains the memory 100 address of the associated QUEUE END location, with the QUEUE END locations containing the addresses of QUEUE START cells associated with the next following tape reel.

The translator 90 responds to the receive tape reel Z information impressed on the bus 89 by the above-considered system functioning by supplying the address of the Z QUEUE START cell, viz., 900, to the queuing circuit 93. In addition, the beginning address of an available pool storage couplet, e.g., 1000, is supplied to the circuit 93 from the storage allocating circuit 74. Further, the record No. 850 and the identity of the request originating station 10_2, are directly translated to

the circuit 93 via the bus 89 and a bus 79.

The queuing circuit 93 is operative to store the tape reel Z, the record No. 850 and the station 10_2 data in the left, center and right bytes of the seized address 1000, and to store in the next following couplet address 1001 the address 901 of the Z QUEUE END storage cell. Also, the contents of the Z QUEUE START location 900 is changed to 1000. This storage status for the queuing memory 100 is shown in FIG. 4B.

In a similar manner, the request from the station set 10_2 for its message No. 32 is linked with the P QUEUE START and STOP locations as shown in FIGS. 4C, with the permanent file location comprising reel P and station 10_2 record No. 2810 information being stored in a common linking couplet beginning with memory 100 address 1002.

When the station set 10_6 requests retrieval of its message No. 42, signals identifying the tape reel P and record No. 1900 are read out from the cross reference file memory 50 and impressed on the bus 89. The translator 90 converts the reel P information into the P QUEUE START address 350 which is communicated, along with the tape reel record No. 1900 and the station 10_6 identity to the request queuing circuit 93. The circuit 93 interrogates the address 350, and is referred by the contents thereof to the pool address 1002. Upon accessing the address 1002, the queuing circuit 93 finds that the reel P record No. 2810 data stored therein exceeds the record No. 1900 which characterizes the permanent file storage location presently being processed.

Accordingly, the circuit 93 seizes the next available linking couplet under control of the storage allocating 74, e.g., the cells 1004 and 1005. The reel and record No. P and 1900, and the station designation 10_6 are stored at the address 1004, with the associated address 1005 having registered therein the

address 1002 containing the next larger reel P record number. Then also, the circuit 93 writes the address 1004 into the P QUEUE START cell 350. The status of the queuing memory 100 following the above-described circuit functioning is shown in FIG. 4D.

When the queuing memory 100 accessor 105 interrogates the queued retrieval list and arrives at the tape reel P portion thereof, it is referred by the contents of the P QUEUE START location 350 to the address 1004. The address 1004 is then interrogated, with the resulting permanent file location data consisting of tape reel P and record No. 1900, and the request originating station identity 10_6 being communicated to the common control unit 30 by the bus 36. The accessor 105 is referred by the contents of the next following cell 1005 to the address 1002 and reads the reel P record No. 2810 and station 10_2 information out of this address to the common control unit 30. Finally, the retrieval request contained on the tape reel Z is communicated to the common control unit 30 when the tape reel Z portion of the queuing memory 100 is interrogated by the accessor 105. In this latter case, the operator display circuit 95 signals an operator that the off line tape reel Z should be mounted on the off line tape unit 40_4.

The common control unit 30 responds to each permanent file location supplied thereto on the bus 35 for communicating the message beginning thereat to the station set originating the corresponding request, as identified by the bus 36. Since the locations are received in a manner ordered by tape reel and record number, viz., P 1900, P 2810 and Z 550, the unit 30 interrogates the permanent file tape reels in a rapid, organized, and efficient manner.

It is to be understood that the above-described arrangement is only illustrative of the application of the principles of the present invention. Numerous other arrangements

may be devised by those skilled in the art without departing from the spirit and scope thereof. For example, the message memory 25, the cross reference memory 50, and the queuing memory 100 may advantageously be combined into a single storage embodiment. Also, selected ones of the functional blocks shown in FIG. 1 may be replaced by stored program subroutines employed in conjunction with the stored program controlled data processing common control unit 30.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In combination in a store and forward communication system a plurality of subscriber stations having messages associated therewith, message permanent storage means, means for sequentially storing the messages associated with any of said stations in said message permanent storage means, cross reference file storage means, means connected to said sequential storing means and responsive thereto for entering the permanent storage location containing the message in the portion of said cross reference storage means dedicated to the station associated with the message, and means responsive to retrieval requests generated by said stations for extracting a corresponding list of permanent storage locations from said cross reference file storage means.

2. A combination as in claim 1 wherein said message permanent storage means comprises a plurality of message permanent storage units, said combination further comprising means for ordering said extracted locations by permanent storage unit.

3. A combination as in claim 2 wherein said location ordering means includes queuing storage means.

4. A combination as in claim 3 wherein said location ordering means further comprises means responsive to the permanent file storage locations generated by said location extracting means for generating an ordered linked storage list of said locations in said queuing storage means.

5. A combination as in claim 4 further comprising means for sequentially interrogating said permanent file storage means in accordance with the locations stored in said queuing storage means.

6. A combination as in claim 2 wherein said permanent storage location entering means comprises station message counting means and indirect addressing means for selectively enabling a particular location in said cross reference file storage means

depending upon the identity of the station set having a message associated therewith and also depending upon the status of said mounting means.

7. A combination as in claim 6 wherein said cross reference file storage means comprises a plurality of common storage file blocks, a plurality of accumulating blocks and a plurality of summary blocks, with a different pair of summary and accumulated blocks being dedicated to each station, and wherein said permanent storage location entering means further comprises storage shifting means for selectively seizing one of said file storage blocks and writing therein the contents of one of said accumulating blocks, detector means responsive to one of said accumulating blocks being full for enabling said storage shifting means, and summary blocks updating means responsive to said detector means for identifying each seized file block in a selected one of said summary blocks.

8. In combination in a store and forward communication system, a plurality of station sets having messages associated therewith, storage means including message memory and cross reference file portions thereof, a translating network and common control means cascaded between said station sets and said message memory portion of said storage means, permanent file memory means, means for sequentially registering in said permanent file memory all messages stored by said station sets in said message memory portion of said storage means, means connected to said common control means and responsive thereto for entering the permanent file memory location containing the messages in storage sections of said cross reference file portion of said message memory dedicated to said station sets, and means responsive to retrieval requests generated by said station sets for extracting a corresponding list of permanent file storage locations from said cross reference file portion of said storage means.

9. A combination as in claim 8 wherein said storage means

further comprises a queuing portion, with said message retrieval organization further comprising means for ordering said extracted permanent file memory locations and for entering said ordered locations in said queuing portion of said storage means.

10. A store and forward communication system which includes apparatus arranged to sequentially register in a permanent file storage location all messages processed by the system independent of their origin and destination, to register the permanent file storage locations of messages processed by the system in portions of a cross reference file storage means dedicated to the particular subscriber originating the messages, and to extract permanent storage locations from the cross reference file storage means in response to retrieval requests generated by the subscribers.

11. A store and forward communication system in accordance with claim 10 further comprising apparatus arranged to register the time and date of origination of each message in the cross reference file storage means portion adjacent to the portions storing the permanent file storage location, and to extract the permanent file storage location information in accordance with information in the retrieval request identifying the time and date of the origination of the requested message.

E

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FIG. 1A

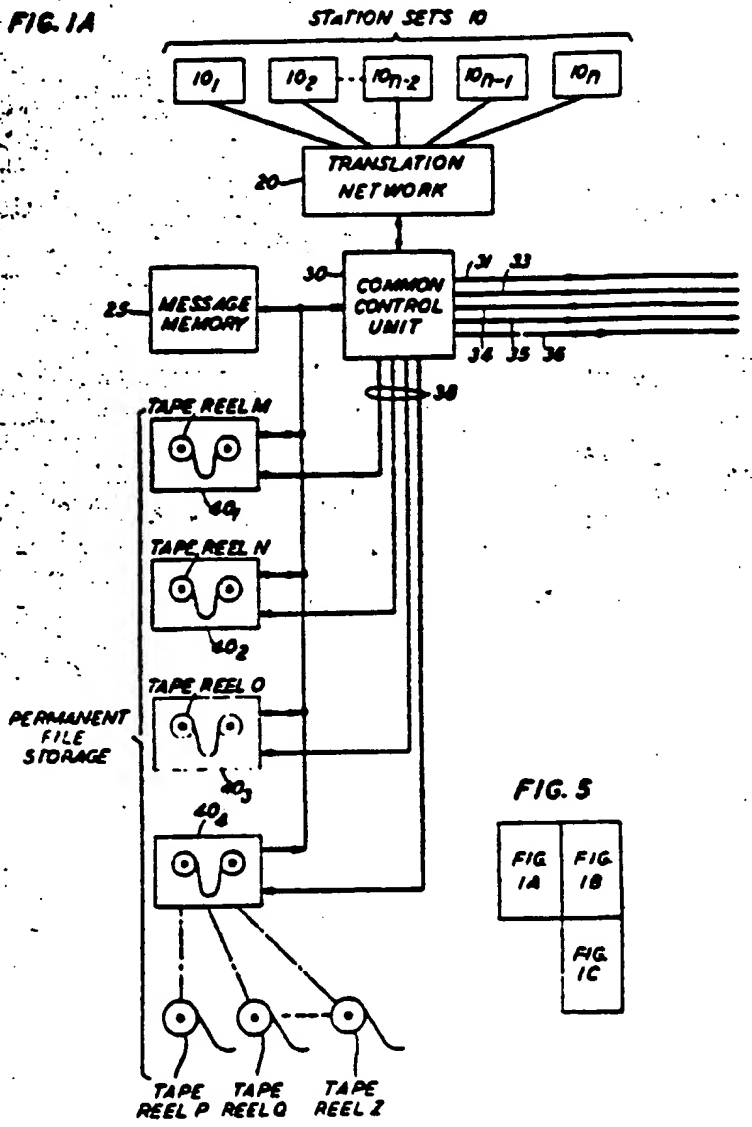

STATION SETS 10
10_1
10_2
10_{n-2}
10_{n-1}
10_n
TRANSLATION NETWORK
20
30
COMMON CONTROL UNIT
31
33
34
35
36
38
25
MESSAGE MEMORY
TAPE REEL M
40_1
TAPE REEL N
40_2
TAPE REEL O
40_3
40_4
PERMANENT FILE STORAGE
TAPE REEL P
TAPE REEL Q
TAPE REEL Z

FIG. 5

FIG 1A
FIG 1B
FIG 1C

FIG. 18

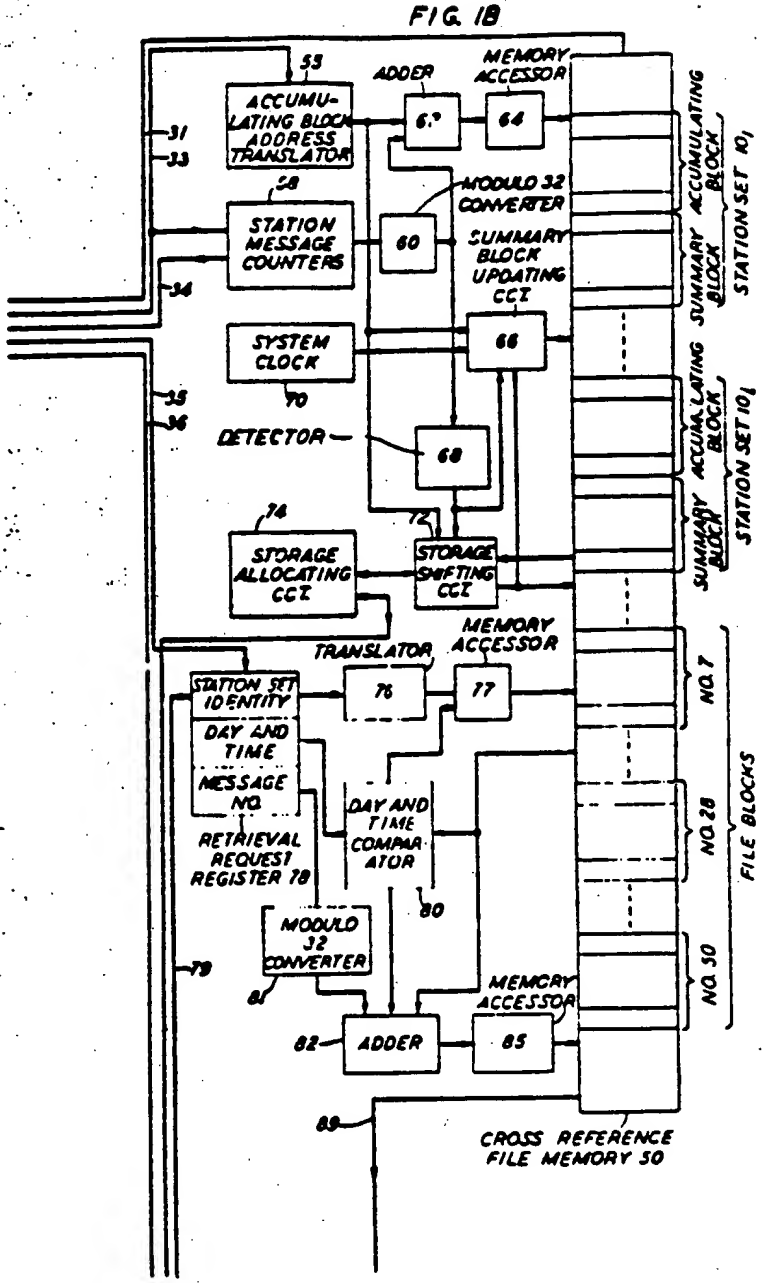
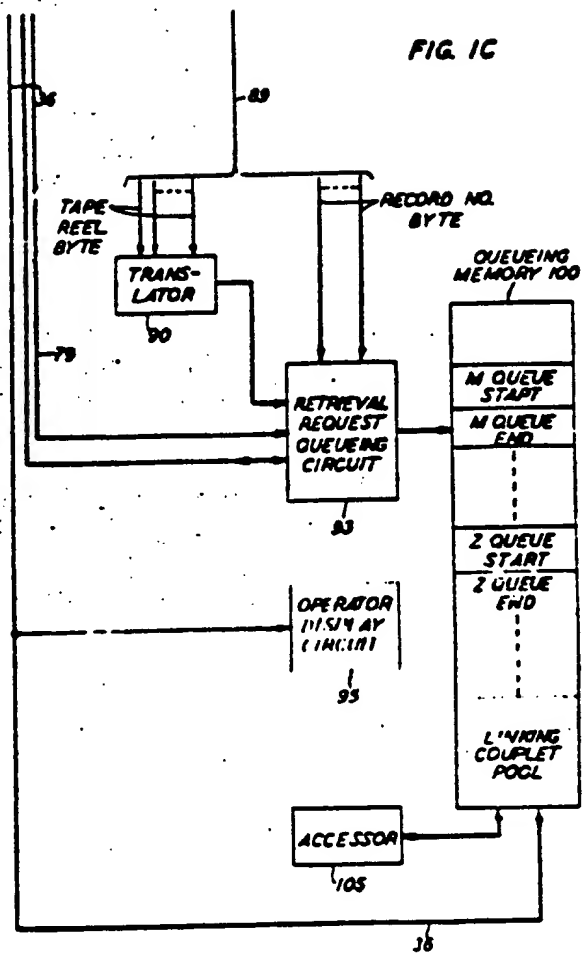

ACCUMU-LATING BLOCK ADDRESS TRANSLATOR
53
ADDER
MEMORY ACCESSOR
64
31
33
STATION MESSAGE COUNTERS
58
MODULO 32 CONVERTER
60
SUMMARY BLOCK UPDATING CCT
66
34
SYSTEM CLOCK
70
35
36
DETECTOR
68
74
72
STORAGE ALLOCATING CCT
STORAGE SHIFTING CCT
TRANSLATOR
MEMORY ACCESSOR
STATION SET IDENTITY
76
77
DAY AND TIME
MESSAGE NO.
DAY AND TIME COMPARATOR
80
RETRIEVAL REQUEST REGISTER 78
MODULO 32 CONVERTER
79
81
MEMORY ACCESSOR
82
ADDER
85
89
CROSS REFERENCE FILE MEMORY 50
ACCUMULATING BLOCK
SUMMARY BLOCK
STATION SET 101
ACCUMULATING BLOCK
SUMMARY BLOCK
STATION SET 101
NO. 1
NO. 28
NO. 50
FILE BLOCKS

FIG. 1C


89
TAPE REEL BYTE
RECORD NO. BYTE
TRANS-LATOR
90
QUEUEING MEMORY 100
79
RETRIEVAL REQUEST QUEUEING CIRCUIT
83
M QUEUE START
M QUEUE END
2 QUEUE START
2 QUEUE END
OPERATOR DISPLAY CIRCUIT
95
LIVING COUPLET POOL
ACCESSOR
105
38

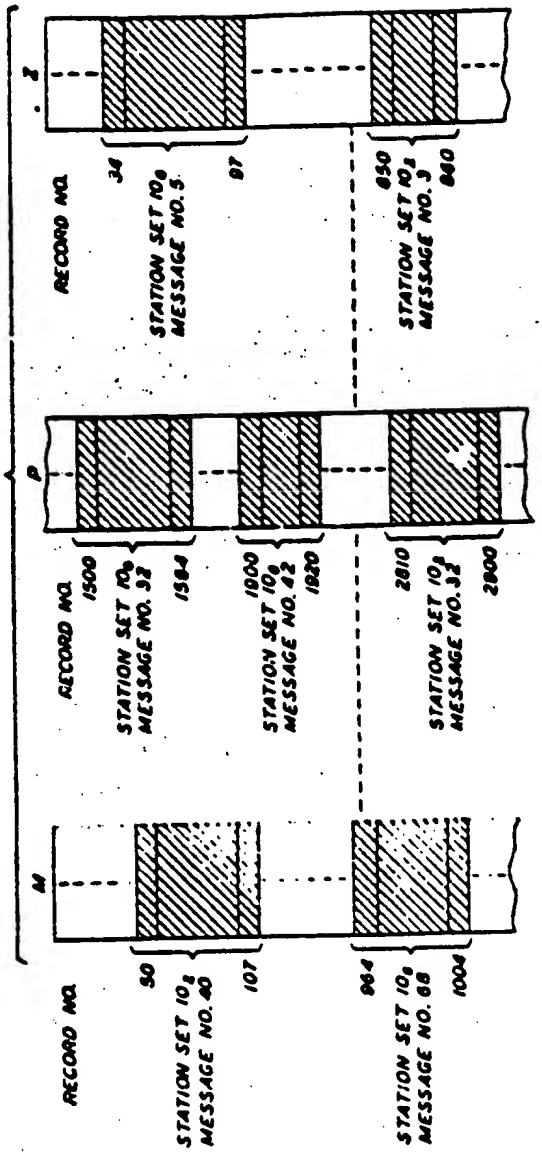

TAPE REELS
Z
RECORD NO.
34
STATION SET NO. MESSAGE NO. 5
87
850
STATION SET NO. MESSAGE NO. 3
860
P
RECORD NO.
1500
STATION SET NO. MESSAGE NO. 33
1584
1000
STATION SET NO. MESSAGE NO. 42
1020
2810
STATION SET NO. MESSAGE NO. 33
2800
M
RECORD NO.
50
STATION SET NO. MESSAGE NO. 40
107
864
STATION SET NO. MESSAGE NO. 68
1004

FIG. 2

FIG. 3A

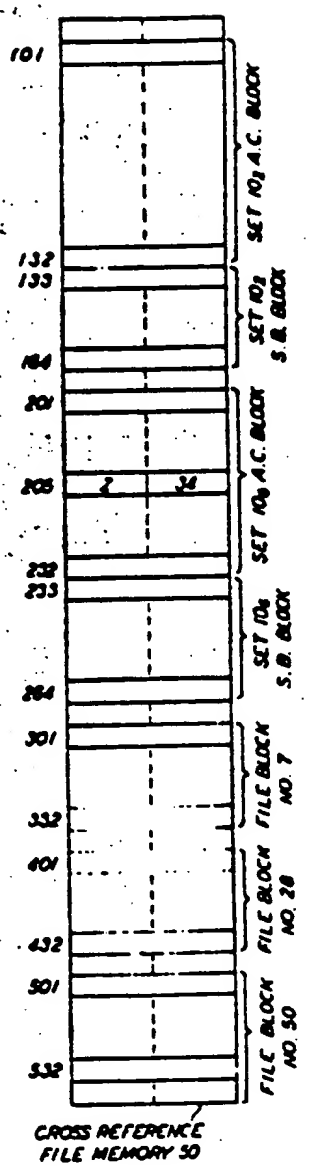

101
132
133
184
201
205
2
34
232
233
264
301
332
401
432
501
532
SET 10₁ A.C. BLOCK
SET 10₁ S.B. BLOCK
SET 10₂ A.C. BLOCK
SET 10₂ S.B. BLOCK
FILE BLOCK NO. 7
FILE BLOCK NO. 28
FILE BLOCK NO. 50
CROSS REFERENCE FILE MEMORY 50

FIG. 3B

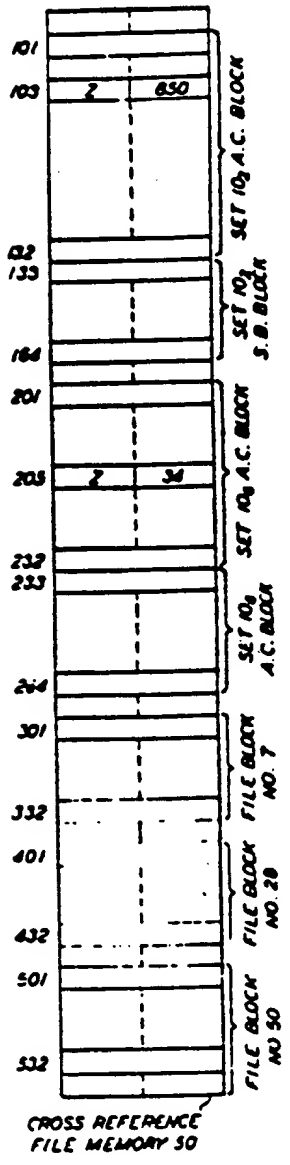

101
103
2
650
132
133
184
201
205
2
34
232
233
264
301
332
401
432
501
532
SET 10₁ A.C. BLOCK
SET 10₁ S.B. BLOCK
SET 10₂ A.C. BLOCK
SET 10₂ A.C. BLOCK
FILE BLOCK NO. 7
FILE BLOCK NO. 28
FILE BLOCK NO. 50
CROSS REFERENCE FILE MEMORY 50

FIG. 3C

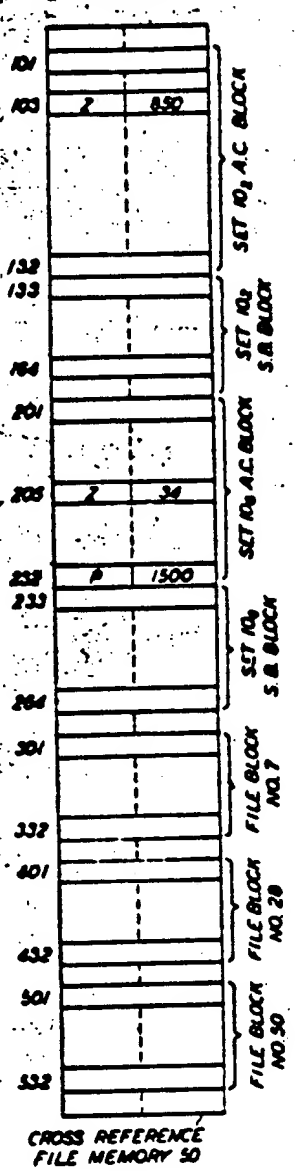

101
103
2
850
SET IO2 A.C. BLOCK
132
133
SET IO2 S.B. BLOCK
164
201
205
2
34
SET IO2 A.C. BLOCK
232
P
1500
233
SET IO2 S.B. BLOCK
264
301
FILE BLOCK NO. 1
332
401
FILE BLOCK NO. 20
432
501
FILE BLOCK NO. 30
532
CROSS REFERENCE FILE MEMORY 50

FIG. 3D

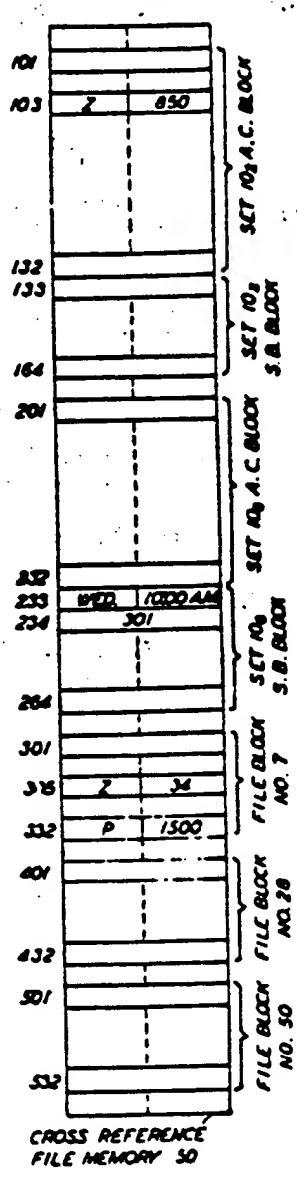

101
103
2
850
SET IO2 A.C. BLOCK
132
133
SET IO2 S.B. BLOCK
164
201
SET IO2 A.C. BLOCK
232
WRD
10000 AA
233
301
SET IO2 S.B. BLOCK
264
301
316
2
34
FILE BLOCK NO. 1
332
P
1500
401
FILE BLOCK NO. 20
432
501
FILE BLOCK NO. 30
532
CROSS REFERENCE FILE MEMORY 50

FIG. 3E

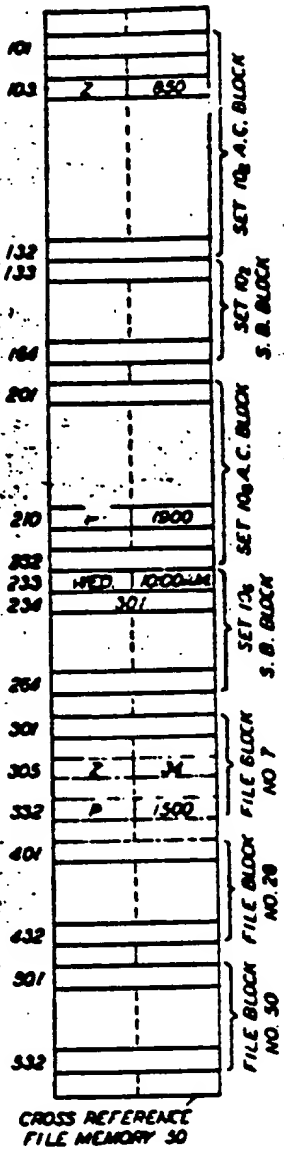

101
103
Z
650
SET 10₂ A.C. BLOCK
132
133
SET 10₂ S.B. BLOCK
168
201
SET 10₂ A.C. BLOCK
210
P
1900
222
232
233
HED.
10000-UK
234
301
SET 10₂ S.B. BLOCK
264
301
305
Z
34
FILE BLOCK NO 1
332
P
1500
401
FILE BLOCK NO. 20
432
501
FILE BLOCK NO. 50
532
CROSS REFERENCE FILE MEMORY 50

FIG. 3F

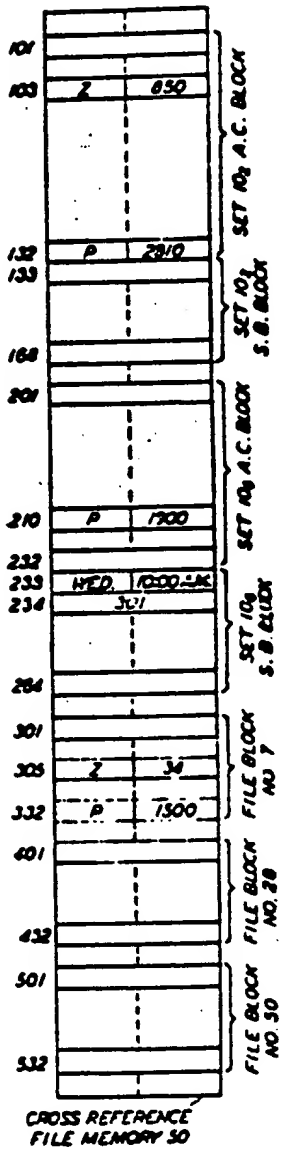

101
103
Z
650
SET 10₂ A.C. BLOCK
132
P
2810
133
SET 10₂ S.B. BLOCK
168
201
SET 10₂ A.C. BLOCK
210
P
1900
222
232
233
HED.
10000-UK
234
301
SET 10₂ S.B. BLOCK
264
301
305
Z
34
FILE BLOCK NO 1
332
P
1300
401
FILE BLOCK NO. 20
432
501
FILE BLOCK NO. 50
532
CROSS REFERENCE FILE MEMORY 50

FIG. 3G

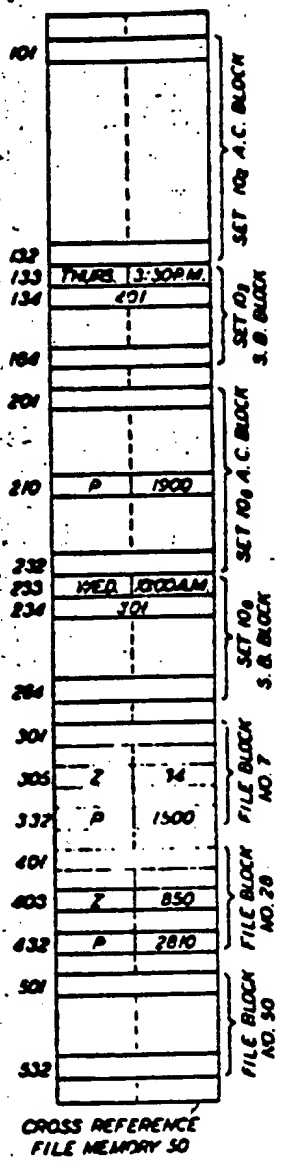

101
102
133
134
184
201
210
232
233
234
284
301
305
332
401
403
432
501
532
THURS. 3:30P.M.
401
P 1900
WED. 10:00AM.
301
Z 34
P 1500
Z 850
P 2810
SET 10a A.C. BLOCK
SET 10a S.B. BLOCK
SET 10b A.C. BLOCK
SET 10b S.B. BLOCK
FILE BLOCK NO. 7
FILE BLOCK NO. 28
FILE BLOCK NO. 50
CROSS REFERENCE FILE MEMORY 50

FIG. 3H

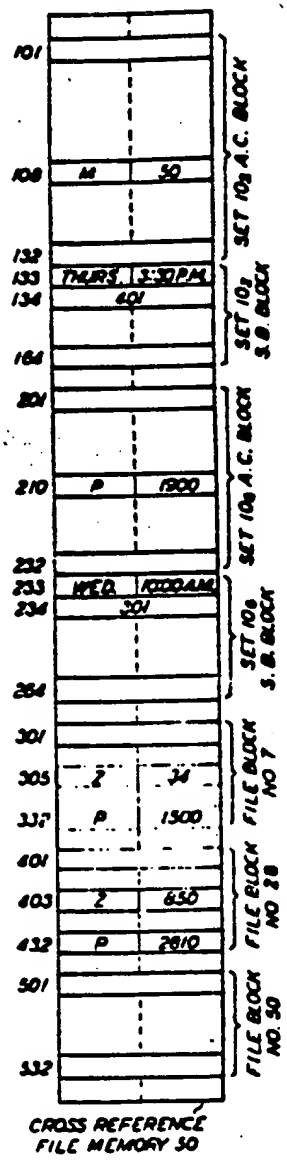

101
108
132
133
134
184
201
210
232
233
234
284
301
305
332
401
403
432
501
532
M 50
THURS. 3:30P.M.
401
P 1900
WED. 10:00AM.
301
Z 34
P 1500
Z 850
P 2810
SET 10a A.C. BLOCK
SET 10a S.B. BLOCK
SET 10b A.C. BLOCK
SET 10b S.B. BLOCK
FILE BLOCK NO 7
FILE BLOCK NO 28
FILE BLOCK NO. 50
CROSS REFERENCE FILE MEMORY 50

FIG. 3I

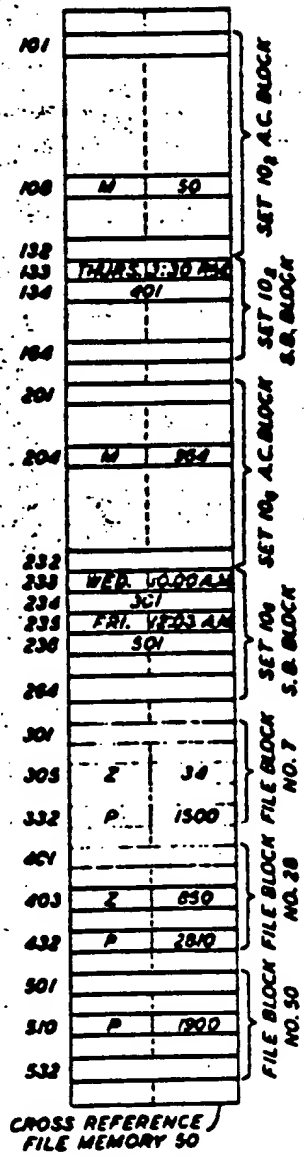

101
108
M
50
SET No. A.C. BLOCK
138
133
134
401
184
SET 10 S.B. BLOCK
201
204
M
864
SET No. A.C. BLOCK
232
233
WED. 10:00 A.M.
234
301
235
FRI. 12:03 A.M.
236
501
SET No. S.B. BLOCK
264
301
305
Z
34
332
P
1500
FILE BLOCK NO. 7
401
403
Z
650
432
P
2810
FILE BLOCK NO. 28
501
510
P
1900
532
FILE BLOCK NO. 50
CROSS REFERENCE FILE MEMORY 50

FIG 4A

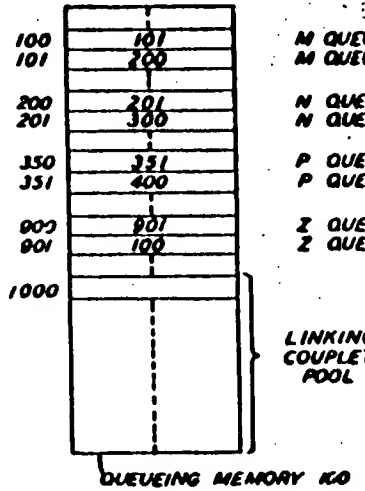
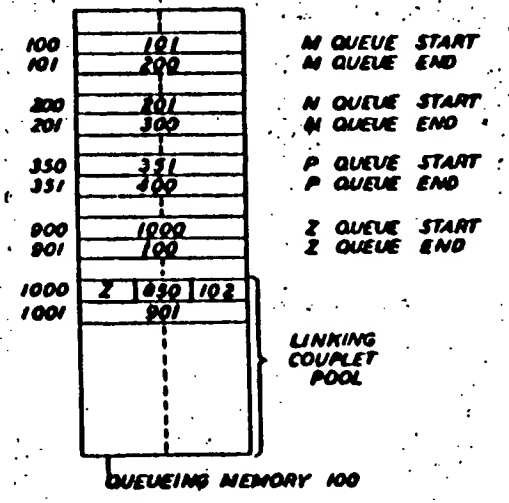


FIG 4B



907211
1710

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STK 28081

FIG. 4D

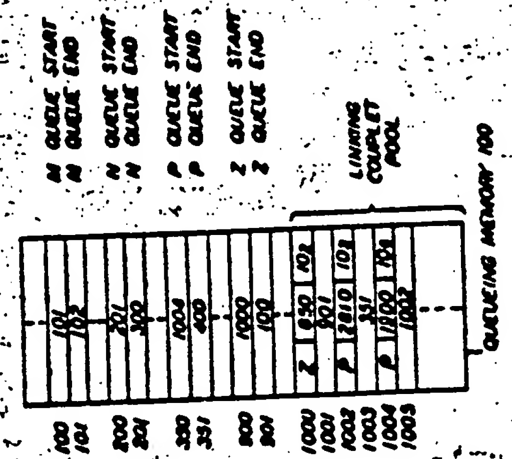
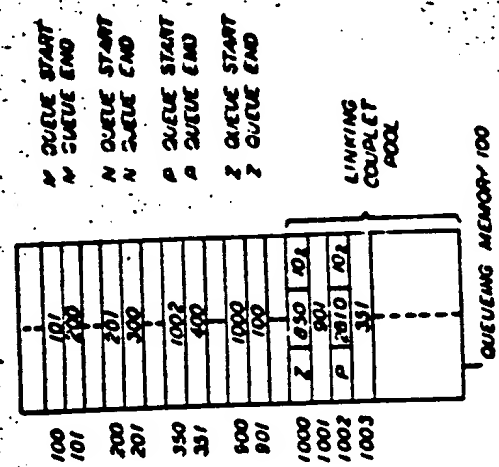

LINKING COUPLET POOL
QUEUEING MEMORY 100

FIG. 4C


LINKING COUPLET POOL
QUEUEING MEMORY 100